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February 28, 2001

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APPLICATION NUMBER: ***60/217,139***

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07-11-00

Box Provisional Application
Commissioner for Patents
Washington DC 20231

PTO/SB/16 (6/95) (Modified)
EXPRESS NO.EL584210574US

PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 C.F.R. 1.53 (b) (2).

Docket Number	1283.002PRV	Type a plus sign (+) inside this box >	+

INVENTOR(s)/APPLICANT(s)

Name (last, first, middle initial)	RESIDENCE (CITY, AND EITHER STATE OR FOREIGN COUNTRY)
Neerman, Haim	Hadera, ISRAEL
Rajwan, Doron	Hadera, ISRAEL

TITLE OF THE INVENTION (280 characters max)

A MULTICAST MODEM IN THE INTERNET

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STATE	Minnesota	ZIP CODE	55402	COUNTRY	United States of America

ENCLOSED APPLICATION PARTS (check all that apply)

XXX Specification Number of Pages 14 ____ Small Entity Statement

____ Drawing(s) Number of Sheets ____ ____ Other (specify) ____

METHOD OF PAYMENT (check one)

XXX A check or money order is enclosed to cover the Provisional filing fees XXX The Commissioner is hereby authorized to charge any additional required fees or credit overpayment to Deposit Account Number: 19-0743	PROVISIONAL FILING FEE AMOUNT	$150.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
XXX No.

___ Yes, the name of the U.S. Government agency and the Government contract number are: ____________

Respectfully submitted,

SIGNATURE Daniel J. Kluth Date July 10, 2000

TYPED OR PRINTED NAME Daniel J. Kluth REGISTRATION NO. 32,146

___ Additional inventors are being named on separately numbered sheets attached hereto.

PROVISIONAL APPLICATION FILING ONLY

07-11-00 A/prov.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re **PROVISIONAL** Patent Application of: Haim Neerman et al.

Title: A MULTICAST MODEM IN THE INTERNET

Docket No.: 1283.002PRV

07/10/00 c973 U.S. PTO

BOX PROVISIONAL APPLICATION
Commissioner for Patents
Washington, D.C. 20231

We are transmitting herewith the following attached items (as indicated with an "X"):

X A PROVISIONAL Patent Application comprising:
  X Specification (14 pgs; no claims nor Abstract)
  X A check in the amount of $150.00 to cover the Provisional Filing Fee.
X Provisional Application Cover Sheet (1 page).
X A return postcard.

Please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
P.O. Box 2938, Minneapolis, MN 55402 (612-373-6900)

By: Daniel J. Kluth
Daniel J. Kluth
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CERTIFICATE UNDER 37 CFR 1.10:

"Express Mail" mailing label number: EL584210574US

Date of Deposit: July 10, 2000

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner for Patents, Attn: BOX PROVISIONAL APPLICATION, Washington, D.C. 20231.

By:
Name: Shawn L. Hise

(NEW FILING)

BandWiz

Provisional Patent Description – no. 2

A Multicast "modem" in the Internet

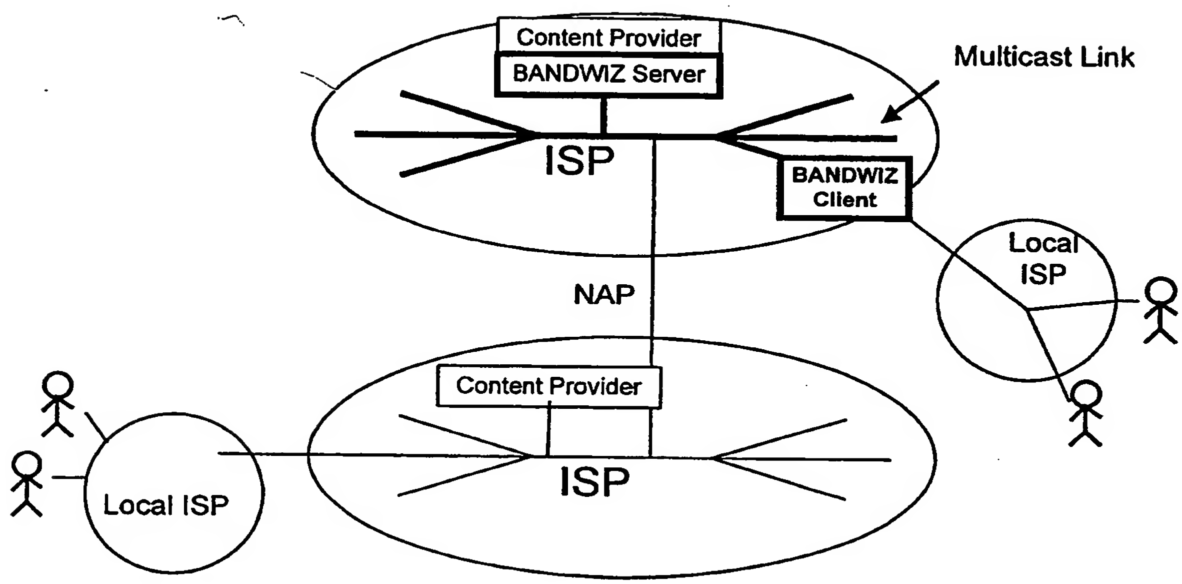
The Field and Background of the Invention

The patent considers the following environment in the Internet. Multicast is not fully opened. There are means (protocols, router configuration, etc) to communicate in multicast mode, especially within a domain. This multicast communication cannot guarantee a reliable end-to-end communication between sender and receivers. As a result multicast is used only for specialized purposes (e.g. streaming) and is not serving the entire needs of content delivery.

In this environment it is suggested to allow efficient content delivery in the Internet via multicast by considering the multicast at a specific domain as a "modem". This means a tool for providing a mean to transport data from one point to another, without consideration of the entire end-to-end communication. This situation is available in the environment described above. The patent proposes, then, an end-to-end system, that is adjusted to the existing protocols and means, but utilize the multicast "modem" in the region it is open. The "modem" is then connected across domains by regular HTTP (tunneling), and for the purpose of end-to-end communication, unicast is used domains where multicast is not available. This way the end-to-end reliable communication is available, in a way that utilizes the available multicast in the internal domain.

The invention:

The invention simply consider a system as described in the following Figure:



References:

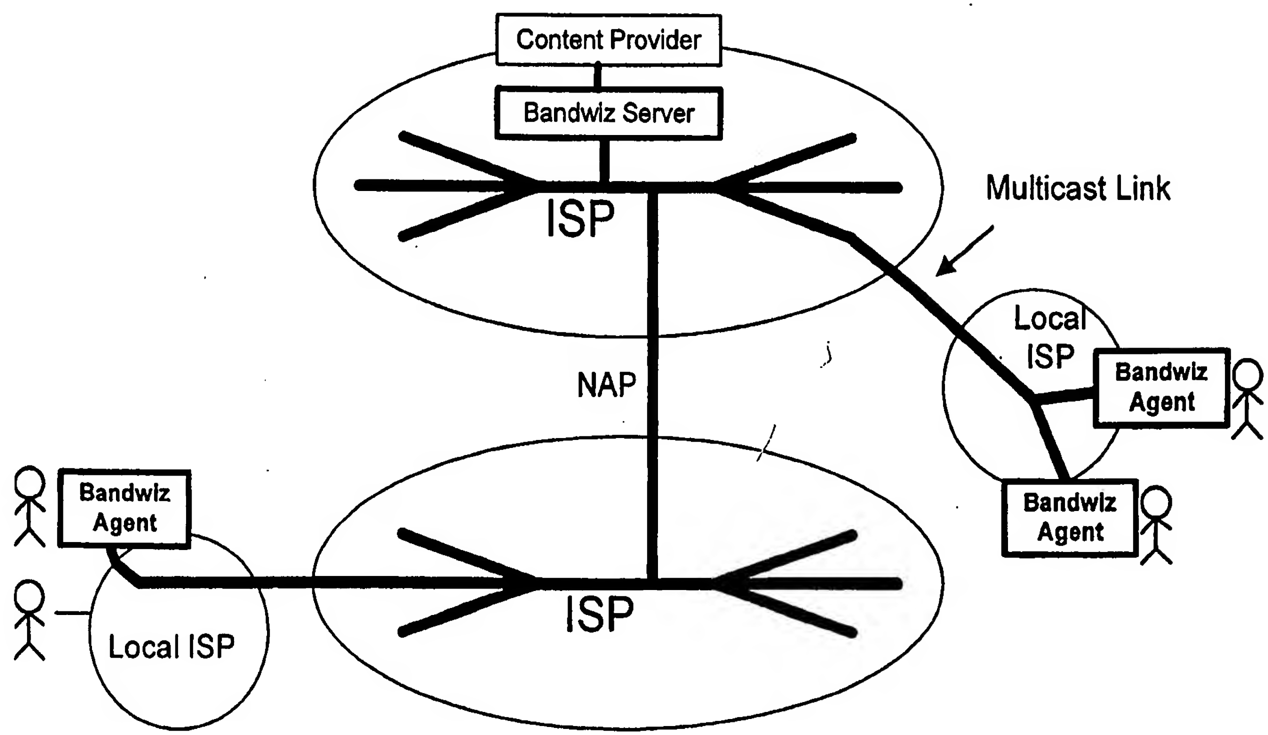
The product and the technology is described in full details in the attached documents, as part of the enclosed power point presentation.

Solutions Based on Bandwiz Technology

60217139.071000

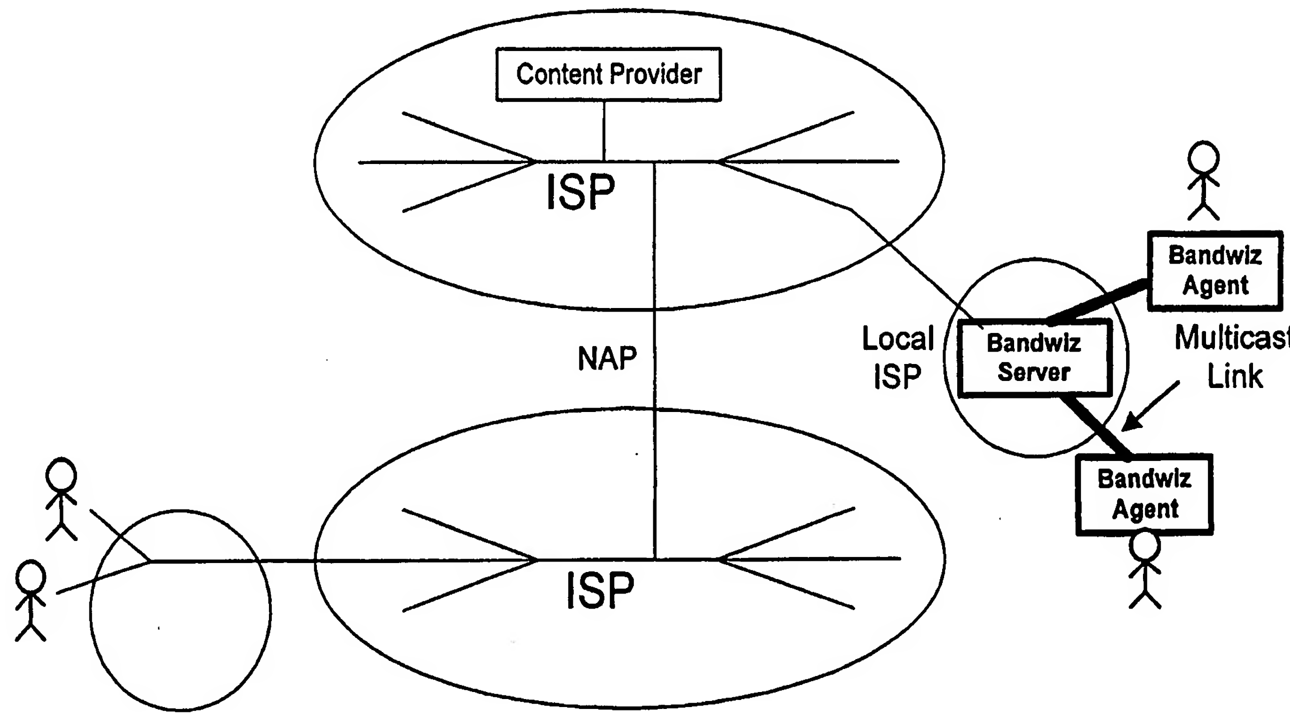
Bandwiz Technology

(Multicast is worldwide deployed)



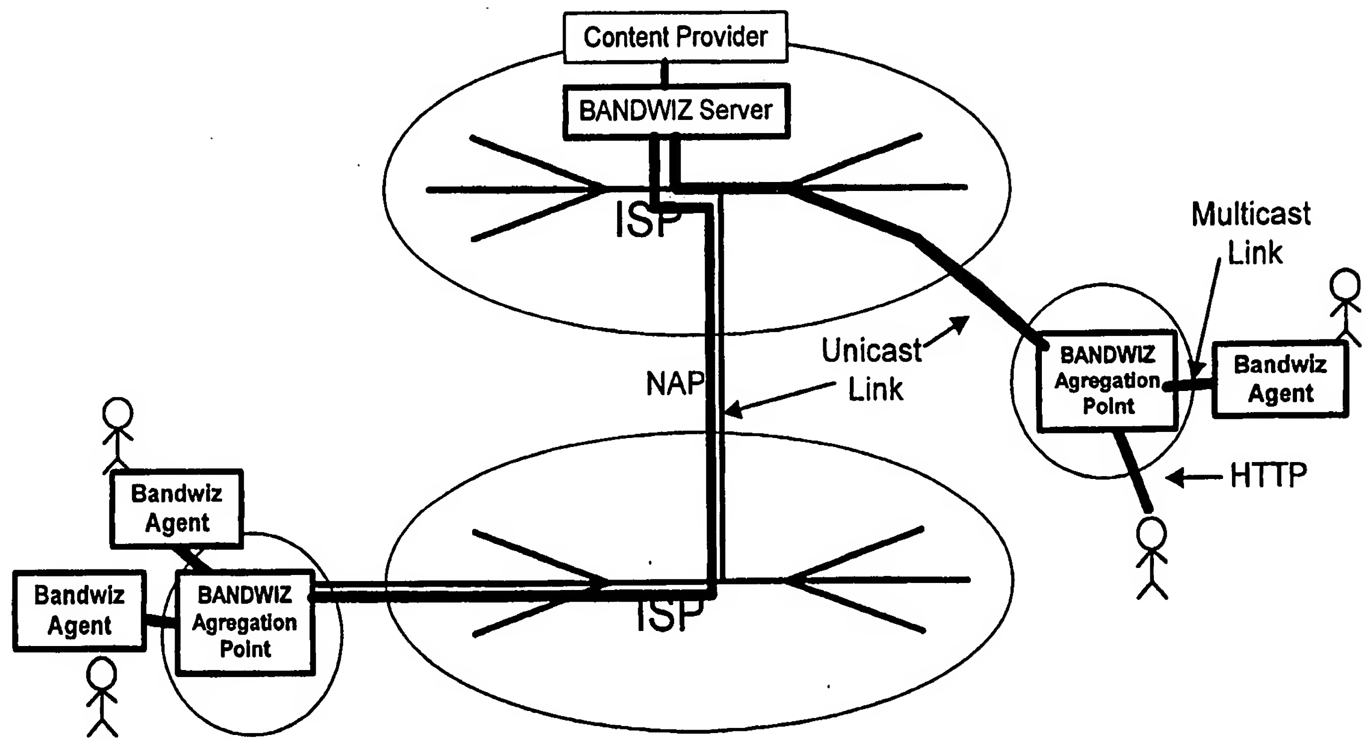
Bandwiz Technology

(Multicast is deployed in autonomous networks)



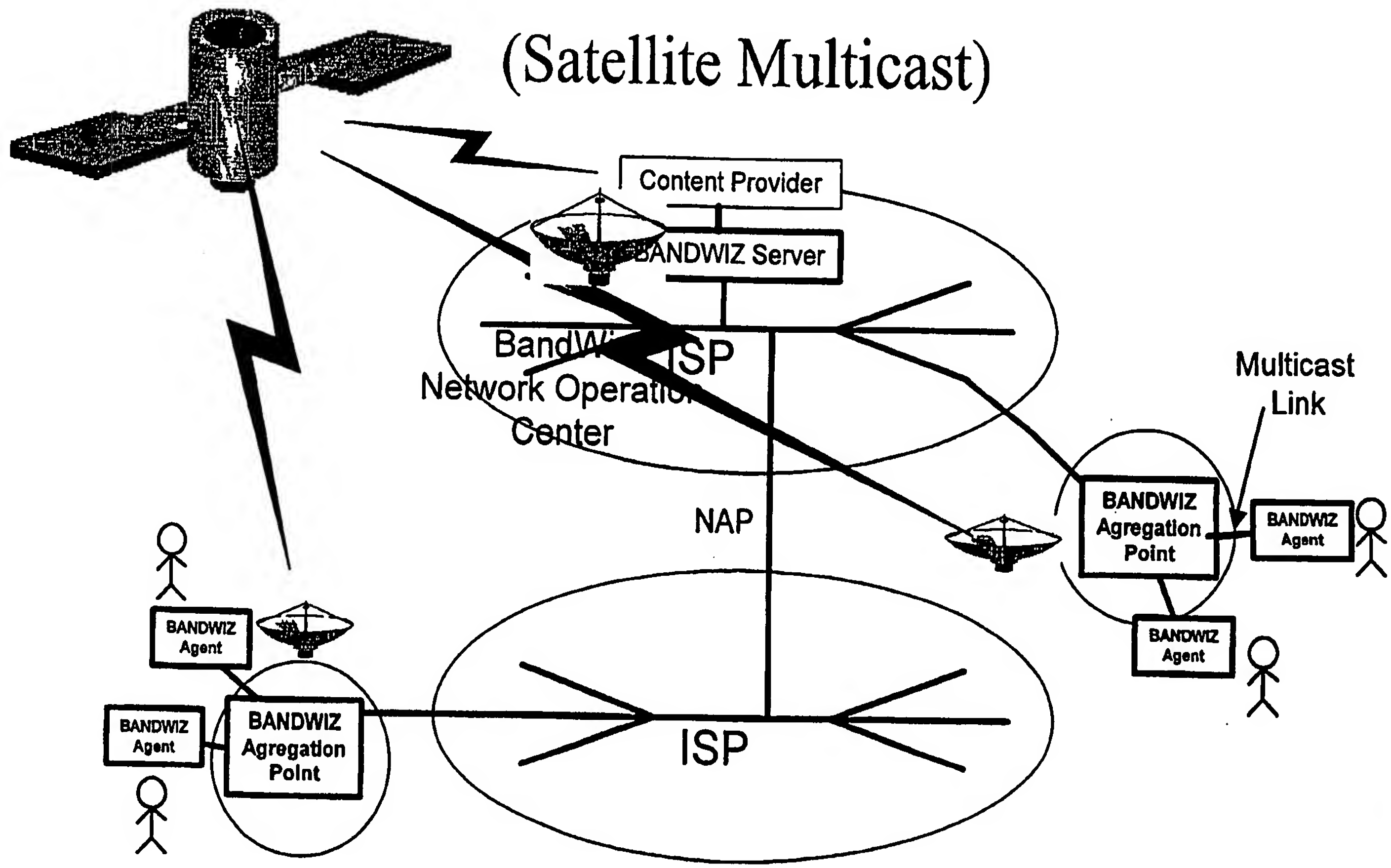
Bandwiz Technology

(Multicast Islands)



Bandwiz Technology

(Satellite Multicast)



BandWiz

Provisional Patent Description – no. 2

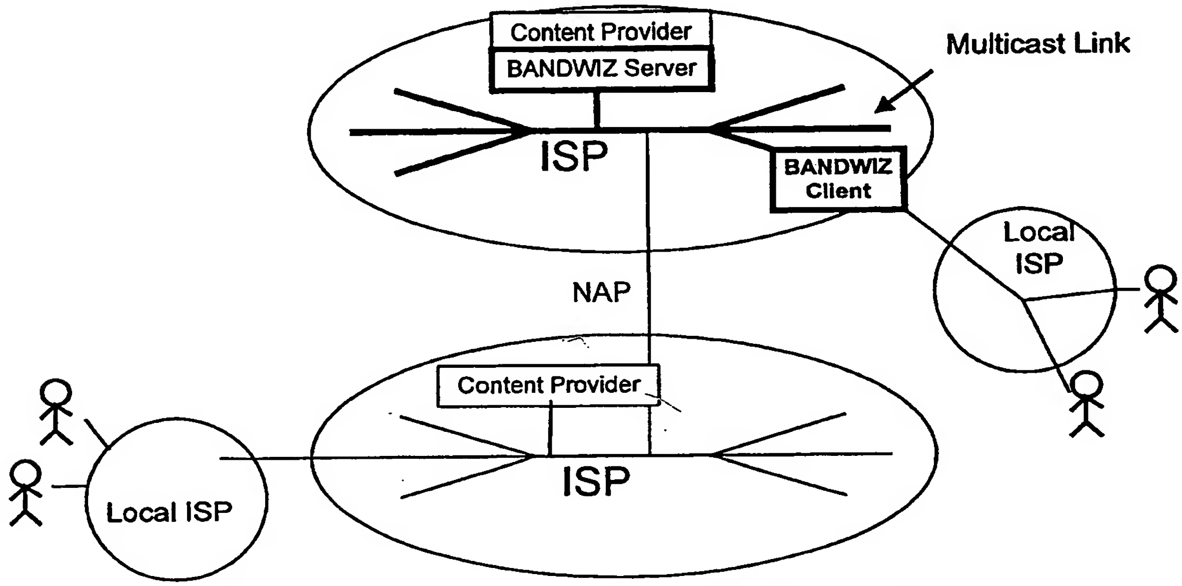
A Multicast "modem" in the Internet

The Field and Background of the Invention

The patent considers the following environment in the Internet. Multicast is not fully opened. There are means (protocols, router configuration, etc) to communicate in multicast more, especially within a domain. This multicast communication cannot guarantee a reliable end-to-end communication between sender and receivers. As a result multicast is used only for specialized purposes (e.g. streaming) and is not serving the entire needs of content delivery.

In this environment it is suggested to allow efficient content delivery in the Internet via multicast by considering the multicast at a specific domain as a "modem". This means a tool for providing a mean to transport data from one point to another, without consideration of the entire end-to-end communication. This situation is available in the environment described above. The patent proposes then a to connect to this multicast modem "tunneling" features to cross domain, and unicast communication in domains where multicast is not available. This way the end to end reliable communication is available, in a way that utilizes the available multicast in the internal domain.

The invention:



The invention simply consider a system as described in the following Figure:

Note that the multicast modem can be implemented via Satellite link

References:

The product and the technology is described in more details in the attached documents, as part of the enclosed power point presentation.

Reliable "On-Demand" Streaming

Streaming – Using blocks

BandWiz multicasting solution is based on "infinite" erasure-code. This is both network efficient, and computation effective (at least when decoding for a single client or small office). The missing part is the capability of streaming. We present below a method that allow a user to get a long stream "on-demand" at a minimal delay, while the sender is multicasting a coded stream of data to all possible receivers.

For example, a user wants to see a 90-minutes movie, and it have the bandwidth in order to see it in real time, meaning that it can download it in **t** < **90** minutes. The regular code used by Bandwiz has a delay of **t** minutes, which can be large.

One solution is to break the content into several, totally independent parts, which we will encode separately. Each part will be transmitted in full speed. This means that the server transmit in higher rate. For example, if a delay of 5 minutes is the maximal delay, the server will need to send 18 times the amount of information.

Assuming that ALL clients have much higher rate then needed for real-time, we can use smaller number of groups. For example, if it is known that **t** < **45** for all clients, we can send the first 10 minutes, next 20 min, next 40 min, and last 20 min, using only 4 blocks instead of 18. In this case the delay will be 5 minutes, as required.

The drawback is, that in order to see the movie with only 5 minutes delay, the client speed should be twice than real-time.

Theoretical limit for streaming – the continuous approach

Suppose the server can send N times the required bandwidth needed for real-time viewing. Suppose the client can accept these many bits. What is the minimal delay?

Define:

- **B** – the bandwidth for real-time viewing, in bps.
- **N** – the server can send **N*B** bps.
- **X** – the length of the content, in seconds.
- **D** – the initial delay, in seconds.
- **F(x)*dx** – the rate, in bps, that the server sends the part **(x, x+dx)**.

The idea is, that the server need to send the minimal number of bits for position **x**, but it has to be sufficient in order to reconstruct it at time **x**, meaning after **D+x** seconds. This means that:

$$F(x)*dx = B*dx / (D+x)$$

Integrating over **F(x)**, from **0** to **X**, gives the total bitrate, **N*B**:

$$N*B = B * \ln((D+X) / D)$$

$$N = \ln(1 + X/D)$$

$$Exp(N) = 1 + X/D$$

$$D = X / (Exp(N) - 1)$$

So, the final result is: when both transmitter and receiver can utilize bandwidth which is N times more than the required for real-time, the delay can be exponentially short, given by the equation:

$$D = X / (Exp(N) - 1)$$

$$X / D = e \,\hat{}\, N - 1$$

Theoretical limit for streaming – the discrete approach

Following the same prove, but using discrete equations instead of integrals, we get about the same result. We divide the file into K block, when each block has a bitrate of **N*B/K**. This bitrate can be above or below **B**. The receiver subscribes to all **K** groups from time **(–D)** to time **0**. Then, at time **0**, the first group is decoded, so the receiver can unsubscribe. The receiver does not get even one redundant bit, but it should have bandwidth that is **N** times more than real-time.

Result:

$$X / D = (1 + N/K)^K - 1$$

(Note that when K is high, we get the continues result as above)

For example, a simple to achieve scheme is to use **K=N**, meaning that there are **N** parts, and each part is exactly in real-time rate, maybe even using uncoded carrousel. In this case:

$$X / D = 2^N - 1.$$

Also, it should not be too difficult to use **N=5, K=10**. In this case, the gain is 56.6. Assuming that we will need to use some safety-guards, the delay is 1 minute per 50 minutes. It means that we can see a movie with 2 minutes delay. Without this scheme, the delay will be 100/5 = 20 minute!

If the receiver can subscribe to each of the groups independently, there is no waste of bits. If not – there is a waste. For example, when N=K=5, there is 158% waste. If we can break it into just 2 groups, the overhead decreases from 158% to 42%. This demonstrates the ability to use less than **K** groups and still save some bits.

This method can be use both in the Internet, and in Video on Demand using the cable TV / DBS. In the later case, the receiver should be a combination of a standard digital receiver and a TiVo. The specification will require the ability to record 2.5MBps, which is the combined rate for 5 channels of 4mbps. It should record it into 10 different streams.

It can be done, for example, by using 3MB of memory in order to hold 1 second, so each 100ms the disk will need to seek to the current stream, and write 250KB. Even the cheapest disk today does it (but I do not know what the MTBF will be).

This means that, unlike standard receiver, the receiver should be able to:

1. Accept **N** times the bandwidth of real-time.
2. Support writing to **K** areas in the disk at once, and reading from one area.
3. Enough disk to store the whole movie, **B*X**.
4. The receiver cannot fast-forward at all.

Theoretical limit for streaming – with limited receiver

What if the receiver cannot accept **N*B** bits per second? Suppose it can only accept **M*B** bits per second, when **M** is bigger than one, but less than **N**.

In this case we will define **L=K*M/N**, which is the number of groups that the receiver can listen to in any given time. The receiver joins the firs **L** groups, gets the first, disconnect from it, and connect to group **L+1**, and so.

A numerical example is: **N = 5, K = 10, M = 2, L = 4**. In this example, the receiver can receive only 2 times the amount of bits. Also, it has a disk that is fast enough in order to write just 4 simultaneous streams. In this case, using **N=2, K=4** would give **X/D=4.06**. Calculation this example gives **X/D=34.13**. This is much above the limitation of this receiver. A receiver without the bandwidth / seek-time limitation could use the entire **N=5, K=10**, giving **X/D=56.66**. We have a good benefit of it.

We gain:

1. The receiver need bandwidth just for **M*B** instead **N*B**.
2. The receiver needs to write just **L** streams, not **K** streams.
3. The receiver needs to store much less then the entire movie.
4. The receiver can fast-forward with lower delay.

We lose:

1. The coding gain is much lower, but still high.
2. In order to gain (1), the receiver should have join/leave command for each of the K sub-streams. It is not relevant for VoD, and simple in IP.

I cannot solve the equation for **X/D**. The equation is:

$$A_q = [(1+N/K)^{q+L+1} - 1] \qquad q = -L-1\ldots-1$$

$$A_q = (1+N/K)*A_{q-1} - N/K*A_{q-L-1} \qquad q = 0\ldots K-L-1$$

When **X/D** is A_{K-L-1}.

In order to solve it, we need to solve equation of order **L+1**. The equation is:

$$Z^{L+1} - (1+N/K)*Z^L + N/K = 0$$

One root of this equation is **Z=1**. It means that it can be factored to:

$$(Z-1) * [Z^L - N/K * (Z^{L-1} + Z^{L-2} + \ldots + Z + 1)]$$

It seems that this equation has only one positive real solution, which is the solution with the largest absolute value. In the example above, the solution is at Z=1.3490, compared to the root at Z=1.5 when the receiver is unlimited.